

THE YAPEENIAN (UPPER LOWER ORDOVICIAN) SUCCESSION IN CENTRAL VICTORIA, AUSTRALIA

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ABSTRACT: Two areas of Upper Lower Ordovician (Yapeenian) rocks from Central Victoria have been mapped in detail. One of the areas is situated west of Gisborne and the other at Chinamans Creek, Muckleford. From this mapping and comparative studies with other areas, a third Yapeenian zone (Ya3), based on the entry of *Apiograptus*, has been designated. Direct superposition of graptolite faunas in the Yapeenian has been demonstrated.

INTRODUCTION

To demonstrate superposition of Yapeenian graptolite zones an area of Ordovician rocks west of Gisborne and a small outcrop of Ordovician rocks north-west of Castlemaine were mapped in detail. These areas were chosen because of their good exposure and ready accessibility. All place names referred to in this paper are shown in Fig. 1.

The Yapeenian stage of the Victorian Lower Ordovician was designated by Harris and Thomas (1938) for *Oncograptus* and *Cardiograptus* beds overlying the Castlemainian *Iso-graptus* beds and underlying the Darriwilian *Glyptograptus* beds.

The name was derived from Yapeen, a small hamlet south-west of Castlemaine. Two zones were recognized by Harris and Thomas:

Ya1 Zone of *Oncograptus*

Ya2 Zone of *Cardiograptus*

In the Ya1, *Oncograptus* enters with *Tristichograptus ensiformis*, *Pseudisograptus manubriatus* and *Didymograptus v deflexus*.

The genus *Tristichograptus* Jackson and Bulman has been known under the name of *Trigonograptus*, principally from the species *T. ensiformis* J. Hall. However, the type specimen of the type species of *Trigonograptus*, *T. lanceolatus* comprises two stipes of a *Didymograptus* lying side by side (Jackson & Bulman 1970). These authors proposed the new name *Tristichograptus* with *T. ensiformis* as the type species.

The genus *Pseudisograptus* was proposed by Beavis (1972) and is here used for the manubriate isograptid species, *Didymograptus manu-*

briatus T. S. Hall, *Isograptus dumosus* Harris and *Isograptus hastatus* Harris.

The Ya1 fauna survives into the Ya2 where it is joined by *Cardiograptus*. The existence of beds containing *Cardiograptus* but not *Oncograptus* were recognized by Harris and Thomas. They suggested that when this occurs the subdivision should be shown as Ya2b and the beds with an *Oncograptus-Cardiograptus* fauna as Ya2a.

Another form figured by Harris and Thomas from the Yapeenian was ? *Glossograptus crudus*.

Recent work by Cooper and McLaurin (1974) has shown that this form has a development that parallels *Pseudisograptus manubriatus*. Its relationship to the glossograptids is uncertain. Cooper and McLaurin described this form as a new genus, *Apiograptus* with ? *Glossograptus crudus* as the type species.

Harris and Thomas failed to point out that *Apiograptus* is restricted to the Ya2 *Cardiograptus* beds. Detailed mapping west of Gisborne and at Chinamans Creek has indicated that this is the case. The details of this mapping follow.

AREA WEST OF GISBORNE

An area 10 km west of Gisborne was mapped at a scale of 1 : 8,330 using enlarged aerial photographs as a mapping base. Critical sections were measured by a tape and compass survey.

The well-entrenched Distil and Saltwater Creeks, which after their confluence become Jackson Creek, drain the area. Drainage direction is to the east and is approximately at right angles to the strike of the basement Ordovician rocks. A nearly continuous section is exposed in the

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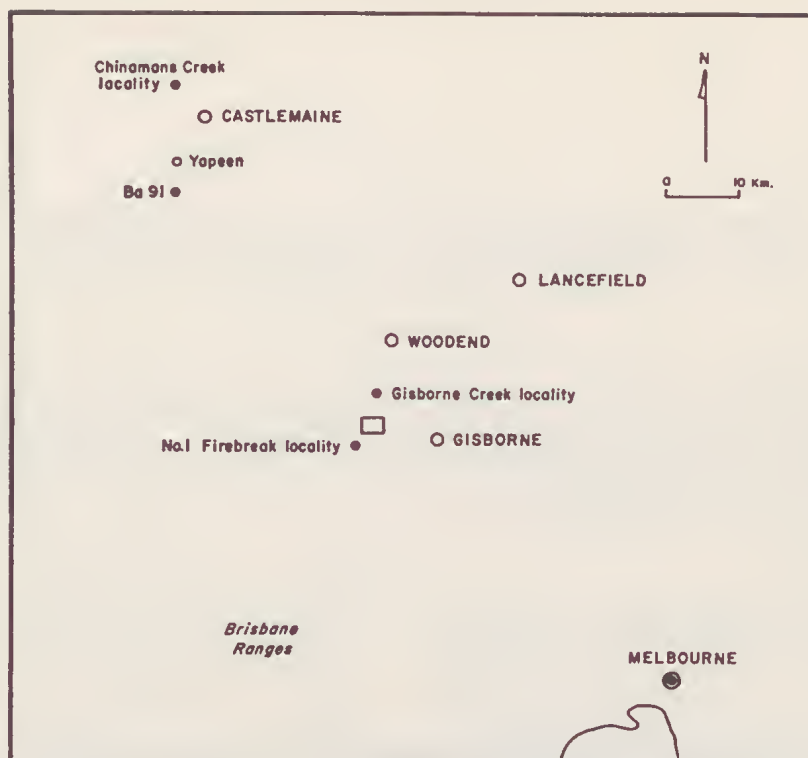


FIG. 1—Locality map. The area enclosed by the rectangle is shown in Fig. 2.

stream courses. Gaps are, however, present due to covering.

All the rocks exposed within the area are of Ordovician age. They range in age from Lower Ordovician (Castlemainian) to Middle Ordovician (Darriwilian) and are younging to the west. They comprise beds of sandstone, siltstone, shale and slate. Graptolites are confined to bands of black slate.

Structurally the area comprises a series of tight plunging folds which bring about frequent repetition of the same bed. Facing was determined by using the cleavage-bedding relationship and by using ripple marks and sole marks.

A detailed description of the sequence follows and reference should be made to the accompanying geological sketch map (Fig. 2) for details of localities. Figures and details of the authorship of the graptolites are given by Thomas (1960).

The sequence is described from east to west, that is in ascending order.

The most easterly mapped graptolite occurrence is the Bullengarook Slate Quarry (locality 1). Sited in massive beds of easterly dipping black slate, the quarry allows ready collection of Upper Castlemainian (Ca3) graptolites. The fauna comprises:

Isograptus victoriae victoriae Harris

I. victoriae maximus Harris.

I. victoriae lunatus Harris

I. victoriae maximo divergens Harris

I. caduceus imitatus Harris

Pseudisograptus dumosus (Harris)

Maeandrograptus tau Harris

Tetragraptus amii Elles and Wood

T. quadribrachiatus J. Hall

T. serra (Brongniart)

Didymograptus mundus T. S. Hall

D. nitidus J. Hall

D. cf. cuspidatus Ruedemann

Dichograptus tenuissimus Harris and Thomas

About 0.5 km to the west westerly, dipping black slates, containing a similar Ca3 fauna, outcrop on Jackson Creek.

Jackson Creek then swings to the north-west where a small quarry has been worked in westerly dipping black slates (locality 3). The slates contain a Lower Yapeenian (Yal) fauna. The following forms are common:

Oncograptus upsilon T. S. Hall

Isograptus victoriae divergens Harris

I. forcipiformis (Ruedemann)

Tristichograptus ensiformis (J. Hall)

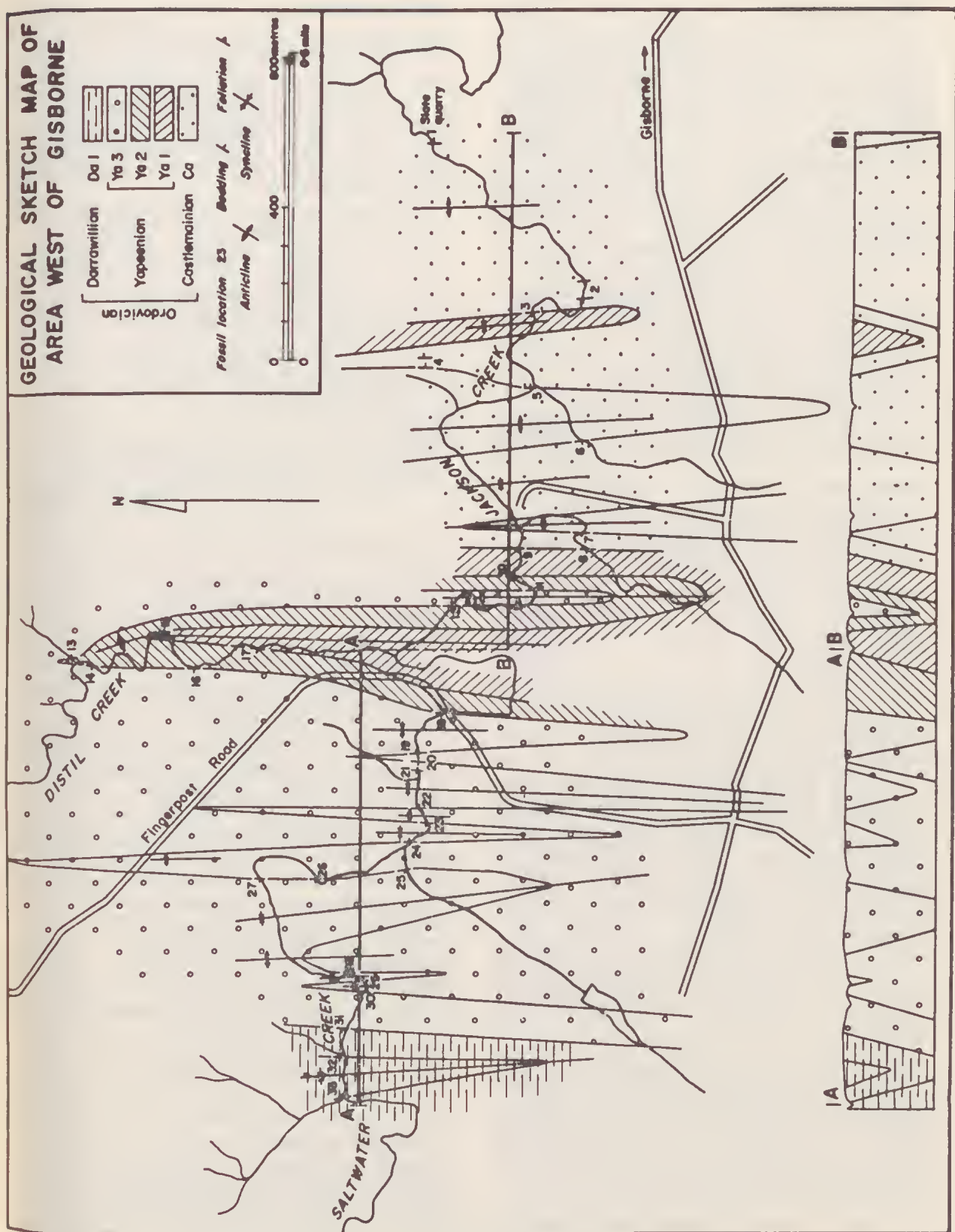


FIG. 2—Geological sketch map of the area west of Gisborne.

It is from this locality that Harris (1933) figured *Oncograptus upsilon* (his Fig. 21).

Further west, at the junction of a small northerly flowing creek with Jackson Creek, a Castlemainian (Ca3) fauna is found in easterly dipping black slates demonstrating the presence of a small syncline, the core of which contains Yapeenian sediments, between localities 2 and 5.

On another small northerly flowing creek, further to the west, a bed of west dipping shale yielded a Ca3 fauna:

Isograptus victoriae victoriae Harris

I. victoriae maximo divergens Harris

To the north-west, on Jackson Creek, a bed of black slate dipping west contains a Lower Yapeenian (Ya1) fauna (locality 9):

Oncograptus upsilon T. S. Hall

Isograptus victoriae divergens Harris

Pseudisograptus manubriatus (T. S. Hall)

Sixty-four metres to the west, a Yapeenian (Ya2) fauna is found in westerly dipping black slates (locality 10):

Oncograptus cf. biangulatus Harris and Keble

Cardiograptus morsus Harris and Keble

Pseudisograptus manubriatus (T. S. Hall)

Skiagraptus gnomicus (Harris and Keble)

Ripple marks in an underlying sandstone bed indicate that the facing is right way up.

Thirty-two metres west a bed of westerly dipping black slate (locality 11) contains the following assemblage:

Apiograptus gisbornensis (Harris and Thomas)

Cardiograptus morsus (narrow form)

Isograptus victoriae divergens Harris

Pseudisograptus manubriatus (T. S. Hall)

Tristichograptus ensiformis (J. Hall)

This bed, stratigraphically higher than the bed outcropping at locality 10, does not contain a typical Ya2 fauna. *Oncograptus* is definitely lacking; the narrow form of *Cardiograptus* is present and a new form, *Apiograptus*, makes its entry. This is the fauna designated as Ya2b by Harris and Thomas (1939).

Assuming an absence of major faulting the thickness of the strata from the bottom of the Ya1 bed at locality 9 to the bottom of the *Apiograptus* bed outcropping at locality 11 is ninety-five metres.

The next outcrop of black slate to the west (locality 12) is very highly cleaved. Graptolites are difficult to extract and poorly preserved, the only recognizable forms found were indeterminate species of *Isograptus* and *Didymograptus*. In keeping with the general structure a high Yapeenian age would be expected for this locality.

Along Distil Creek, to the north-east of locality 12, a north plunging anticline runs parallel to

the stream valley. The core of the anticline contains beds with a Ya2 fauna (localities 15, 17):

Cardiograptus morsus Harris and Keble

Oncograptus upsilon Harris and Keble

These beds are overlain to the west and the north by beds with *Apiograptus gisbornensis*.

At locality 19 on Saltwater Creek is a bed of black slate dipping steeply east. The fauna from the base of this bed is:

Oncograptus biangulatus Harris and Keble

Pseudisograptus manubriatus (T. S. Hall)

At 0.8 m above this horizon the following fauna was collected:

Apiograptus crudus (Harris and Thomas)

Cardiograptus morsus Harris and Keble

Tristichograptus ensiformis (J. Hall)

Dichograptus cf. octobrachiatus J. Hall

Isograptus victoriae divergens Harris

I. caduceus imitatus Harris

Phyllograptus sp.

Apiograptus crudus is distinguished from *Apiograptus gisbornensis* by its wider rhabdosome.

This fauna is of interest because of the association of *Oncograptus* and *Apiograptus crudus*. It has already been demonstrated, in the section along Jackson Creek, that *Apiograptus gisbornensis* beds succeed those with *Oncograptus*. This bed with *Apiograptus crudus* is considered as basal Upper Yapeenian. It is repeated by folding then overlain to the west (locality 21) by a bed with an *Apiograptus gisbornensis*, *Cardiograptus morsus* (narrow form) fauna which is more typical of the Upper Yapeenian.

The 3 m thick bed of black slate outcropping at locality 21 is repeated by folding nine times in a distance of approximately 640 m to the west.

At locality 24, just downstream from the intersection of an unnamed northerly flowing creek with Saltwater Creek, a more complete collection of Upper Yapeenian graptolites may be made:

Apiograptus gisbornensis (Harris and Thomas)

Cardiograptus morsus (narrow form)

Isograptus victoriae divergens Harris

I. victoriae maxima divergens Harris

Pseudisograptus manubriatus (J. Hall)

Didymograptus v. deflexus Harris

Skiagraptus gnomicus (Harris and Keble)

Maendrograptus tau Harris

Phyllograptus densus Ruedemann

Dichograptus octobrachiatus J. Hall

Loganograptus sp.

The westerly dipping black slate outcropping at locality 30 yielded:

Apiograptus gisbornensis (Harris and Thomas)

Cardiograptus morsus (narrow form)

About one hundred and twenty metres to the west is a one metre thick bed of black slate

dipping west (locality 31) containing a Darriwilian fauna (Da1):

Glyptograptus austrodentatus austrodentatus Harris and Keble

Paraglossograptus tentaculatus (J. Hall)

Glossograptus acanthus Elles and Wood

Tristichograptus ensiformis (J. Hall)

Eighty metres to the west a three metre thick bed of westerly dipping black slate (locality 32) contains:

Glyptograptus austrodentatus austrodentatus Harris and Keble

Isograptus victoriae divergens (Harris)

Tristichograptus ensiformis (J. Hall)

Although stratigraphically higher than the bed at locality 31, there is little difference between the two faunas which are both of Da1 age.

This section demonstrates the progression from an isograptid fauna of the Castlemainian to the *Oncograptus-Cardiograptus* fauna of the lower to Middle (Ya1-Ya2) Yapeenian and then to the entry of *Apiograptus* in higher Yapeenian beds which is followed by *Glyptograptus* in the Lower Darriwilian (Da1).

CHINAMANS CREEK, MUCKLEFORD

This important locality is the type locality of *Cardiograptus morsus* and *Apiograptus crudus*. Good exposure allows bed by bed collecting of graptolites. Sandstone and shale beds, dipping east at between 75° and 80° and striking at 347° outcrop on the north bank of Chinamans Creek, 6.4 km north-west of Castlemaine. Grid reference from the Melbourne 1 : 250,000 sheet is 221,432.

The sequence, from top to bottom of the exposure, is summarized in Table 1.

The Yapeenian (Ya2) *Oncograptus-Cardiograptus* fauna is found in beds two to four. Bed four passes into bed five: both beds have identical lithology. However, in the higher bed *Oncograptus* is absent and *Cardiograptus morsus* (narrow form) makes its entry.

An unfossiliferous interval of 0.6 m (bed six) separates the *Apiograptus* fauna of bed seven from the underlying *Oncograptus* fauna. This sequence is very similar to that already described from locality 19 on Saltwater Creek.

The fauna in bed nine is the more typical *Apiograptus gisbornensis* Upper Yapeenian fauna which is identical to the fauna already described from the area west of Gisborne.

RANGE OF *Oncograptus* and *Cardiograptus*

It has been shown by earlier authors and this work that *Oncograptus*, as *Oncograptus upsilon*, enters the graptolite sequence with *Tristicho-*

graptus ensiformis and *Pseudisograptus manubriatus* ushering a new event, which by definition, is the beginning of the Yapeenian.

Oncograptus has been reported from Upper Castlemainian beds outcropping at McKenzies Hill near Castlemaine by Harris (1933). This is a doubtful record, as a recent collection from this locality contained a Castlemainian fauna and no examples of *Oncograptus* was found. The locality from which Harris apparently collected his specimens is sited in a small water race. A block containing *Oncograptus* could have been transported from nearby Yapeenian sediments during construction of the race.

On the other hand, *Oncograptus* survives into the Darriwil. *Oncograptus biangulatus* outlives *Oncograptus upsilon* and is found in beds of Lower Darriwilian (Da1) age. For example, a bed of pink shale outcropping on the Number One Firebreak track, 0.8 km south of the Blackwood Road near Gisborne yielded:

Glyptograptus austrodentatus austrodentatus Harris and Keble

Pterograptus sp.

Isograptus victoriae maximo divergens Harris

I. victoriae velatus Harris

Cardiograptus morsus (narrow form)

Oncograptus biangulatus Harris and Keble

The presence of *Glyptograptus* and *Pterograptus* together with the absence of *Apiograptus* place this fauna as basal Darriwilian. *Cardiograptus* and *Oncograptus* are leftovers from the Yapeenian and are not found in higher Darriwilian beds. For a genus that ranges through the Upper Yapeenian time interval represented by the *Apiograptus* fauna, *Oncograptus* is unusually scarce in beds of this age. It has been found closely associated with *Apiograptus crudus* only at locality 19 on Saltwater Creek. At Chinamans Creek, *Apiograptus* occurs 2.5 metres higher in the sequence than *Oncograptus*. One explanation for the scarcity of *Oncograptus* during the Upper Yapeenian could be the method of graptolite emplacement by turbidity currents and the ensuing grading of the fauna, examples of which have been described by Moors (1968).

The existence of *Cardiograptus* in Lower Darriwilian beds is well established in Victoria. Harris and Thomas (1937) recorded *Cardiograptus morsus* (narrow form) with *Glyptograptus austrodentatus austrodentatus* and *Skia-graptus gnomonicus* from Sapling Gully in the Brisbane Ranges. From black slates outcropping along the upper reaches of Gisborne Creek this author has collected *Cardiograptus morsus* (narrow form) associated with a typical Darriwilian (Da1) fauna:

TABLE 1

CHINAMANS CREEK SECTION

<i>Bed</i>	<i>Fauna</i>	<i>Thickness in Metres</i>
12 Yellow silty shale	Not fossiliferous	1.3
11 Brown quartzite	Not fossiliferous	0.6
10 Yellow micaceous sandstone with minor shale beds	Not fossiliferous	8.5
9 Orange shale	<i>Apiograptus</i> cf. <i>gisbornensis</i> (Harris and Thomas) <i>Cardiograptus morsus</i> (narrow form) <i>Skiagraptus gnomonicus</i> Harris and Keble <i>Didymograptus v deflexus</i> Harris <i>Tristichograptus ensiformis</i> (J. Hall) <i>Isograptus victoriae divergens</i> Harris	0.8
8 Massive yellow sandstone with minor sandy shale beds	Not fossiliferous	3.3
7 Pink shale	<i>Apiograptus crudus</i> (Harris and Thomas) <i>Pseudisograptus manubriatus</i> (T. S. Hall) <i>Tristichograptus ensiformis</i> (J. Hall) <i>Phyllograptus</i> sp.	0.5
6 Orange shale	Not fossiliferous	0.6
5 Bluff shale	<i>Cardiograptus morsus</i> Harris and Keble <i>Cardiograptus morsus</i> (narrow form) <i>Tristichograptus ensiformis</i> (J. Hall) <i>Isograptus victoriae divergens</i> Harris <i>Tetragraptus serra</i> (Brongniart) <i>Didymograptus</i> sp. <i>Phyllograptus</i> cf. <i>densus</i>	1.9
4 Bluff shale	<i>Cardiograptus morsus</i> Harris and Keble <i>Oncograptus biangulatus</i> Harris and Keble <i>Phyllograptus densus</i> Monsen <i>Isograptus victoriae divergens</i> Harris <i>Didymograptus v deflexus</i> Harris	0.3
3 Yellow sandy shale	Fossils rare <i>Tetragraptus</i> sp.	0.8
2 Bluff to pink shale	Fossils rare <i>Didymograptus v deflexus</i> Harris <i>Tetragraptus</i> sp. <i>?Oncograptus</i> sp.	0.8
1 White sandstone	Unfossiliferous	3+

Glyptograptus austrodentatus austrodentatus Harris and Keble

Glossograptus cf. *acanthus* Monsen

Paraglossograptus tentaculatus (J. Hall)

Finally Thomas (1935) records *Cardiograptus morsus* together with *Glyptograptus* from a spoil heap of the old Guildford Plateau shaft north-east of Strangways Railway Station.

It is therefore surprising that *Cardiograptus* was not found in the mapped Lower Darriwilian beds along Saltwater Creek. Such faunal variations, however, are not uncommon in the Victorian sequence.

SUMMARY OF YAPEENIAN ZONATION

Bed by bed collecting of graptolites from Chinamans Creek does demonstrate the superposition of the *Apiograptus* fauna above an *Oncograptus-Cardiograptus morsus* fauna. Detailed mapping in the area west of Gisborne demonstrates details of the Yapeenian sequence, although direct superposition cannot always be distinguished due to complicated structure and apparent grading of fauna.

As a result of this mapping the zoning of the

Yapeenian can be redefined as shown in Table 2. A new Ya3 zone is introduced, and this replaces the Ya2b zone designated by Harris and Thomas (1938). The Ya3 zone is defined by the interval represented by the incoming of *Apiograptus* to the incoming of *Glyptograptus*.

The Ya3 zone can be divided into two sub-zones based upon the two species of *Apiograptus*. *Apiograptus crudus* enters the basal Ya3 beds but soon gives way to *Apiograptus gisbornensis* which is much more widespread in its occurrence. Basal Ya3 beds have been found only at Chinamans Creek and along the Saltwater Creek. Accordingly this subdivision is not formalized.

The *Isograptus victoriae* fauna has been left out of the tabulation as this fauna has little stratigraphic value during the Yapeenian. *Isograptus victoriae divergens* appears in basal Yapeenian beds and remains in force during the Yapeenian.

Each of the three Yapeenian zones is characterized by the entry of a new genus:

Ya3 Zone of *Apiograptus*

Ya2 Zone of *Cardiograptus*

Ya1 Zone of *Oncograptus*

Each of the Yapeenian zones is a discrete

TABLE 2
UPPER LOWER ORDOVICIAN ZONATION

Fauna		Zone
<i>Glyptograptus austrodentatus austrodentatus</i>	Harris and Keble	
<i>Tristichograptus ensiformis</i>	(J. Hall)	
<i>Paraglossograptus tentaculatus</i>	(J. Hall)	
<i>Glossograptus acanthus</i>	Elles and Wood	Darriwilian
<i>Cardiograptus morsus</i> (narrow form)		(Da1)
<i>Oncograptus biangulatus</i>	Harris and Keble	
<i>Apiograptus gisbornensis</i>	(Harris and Thomas)	
<i>Cardiograptus morsus</i> (narrow form)	(J. Hall)	
<i>Tristichograptus ensiformis</i>	(T. S. Hall)	Yapeenian
<i>Pseudisograptus manubriatus</i>	(Harris and Thomas)	(Ya3)
<i>Apiograptus crudus</i>		
<i>Cardiograptus morsus</i> (narrow form)	(J. Hall)	
<i>Tristichograptus ensiformis</i>	(T. S. Hall)	
<i>Pseudisograptus manubriatus</i>	Harris and Keble	
<i>Oncograptus biangulatus</i> (only at the base)		
<i>Cardiograptus morsus</i>	Harris and Keble	
<i>Oncograptus biangulatus</i>	Harris and Keble	
<i>Oncograptus upsilon</i>	T. S. Hall	Yapeenian
<i>Tristichograptus ensiformis</i>	(J. Hall)	(Ya2)
<i>Pseudisograptus manubriatus</i>	(T. S. Hall)	
<i>Oncograptus upsilon</i>	T. S. Hall	
<i>Tristichograptus ensiformis</i>	(J. Hall)	Yapeenian
<i>Pseudisograptus manubriatus</i>	(T. S. Hall)	(Ya1)
<i>Isograptus victoriae victoriae</i>	Harris	
<i>I. victoriae maximus</i>	Harris	Castlemainian
<i>I. victoriae maximo divergens</i>	Harris	(Ca3)

mappable unit. From mapping in the area west of Gisborne, the Ya1 zone has a thickness of 64 m, the Ya2 zone 31 m and the Ya3 zone 130 m. In calculating thicknesses no estimation of modification due to faulting or thickening due to folding has been made.

The Ya3 zone may be recognized in all major areas of Yapeenian outcrop in Victoria, especially the type area at Yapeen. From a collection, held in the National Museum of Victoria and made from the Victorian Geological Survey locality, Ba91, south of Yapeen, this author has identified:

Apiograptus gisbornensis (Harris and Thomas)

Cardiograptus morsus (narrow form)

Didymograptus v deflexus Harris

Pseudisograptus dumosus (Harris)

Ba91 is the type locality of *Didymograptus v deflexus*. The fauna from this locality is identical with faunas already described from Gisborne and Chinamans Creek.

Apiograptus has been recorded from Lancelfield by Harris and Thomas (1935). The Ya3 zone is also found at other localities in the Gisborne-Woodend area.

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